PLANT PROTECTION OVERSEAS REVIEW

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PLANT PROTECTION OVERSEAS REVIEW

A PERIODICAL SURVEY OF NEW DEVELOPMENTS IN THE CONTROL OF PESTS, DISEASES AND WEEDS

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CONTENTS

EDITORIAL

IN fulfilment of the hope expressed in our last issue to print further articles on up to date weedkilling methods, we now include one on this subject by Dr. E. Holmes, reprinted from the magazine *Farming*, by kind permission of the Editor of that paper.

In this issue of the *Review* will be found also two articles on the subject of phosphorus insecticides, products of considerable interest and importance at the present time and becoming increasingly so, and the first article of a series on the treatment of seed with chemical seed-dressings, in which method of crop protection there are continually fresh developments.

We have also included a second series of " Technical Brevities," which are brief items of information on various matters relating to plant protection, abstracted from published literature and other sources.

As mentioned in previous numbers of this *Review*, we shall always welcome contributions from our overseas readers on subjects dealing with crop protection.

CHEMICAL WEED CONTROL IN GRASSLAND

By Dr. E. HOLMES, M.SC., F.R.I.C.

(Reproduction of an article appearing in "Farming," May, 1950, by kind permission of the Editor.)

THE gradual rise of farm labour costs and the increasing interest of chemical manufacturers in agriculture led to the introduction of chemical weed control at the beginning of the present century. As with all such developments it started off rather crudely and rather haltingly. Until the 'twenties we had kainit and calcium cyanamide, both applied as dusts, and dilute copper sulphate solution for the selective killing of broad-leaved weeds in cereals. They were not very efficient and they were not always as selective as could be wished, but they represented a definite step forward and the first two at least added some plant food to the soil.

In the 'twenties dilute sulphuric acid came into the picture, at first in France, and proved rather more efficient though a difficult product to handle. Many operators have found that the repairs to conventional type sprayers of this material during and at the end of each season are equivalent to writing off each machine each season. In the early 'thirties, again in France, di-nitro-ortho-cresol (DNOC) was introduced and, although being a dangerous chemical, has proved its worth in many weed-killing operations.

In 1940, we in Britain discovered the first of the so-called hormone selective or plant-growth regulator weed-killers. Developments in the past decade have been extremely rapid. After six years of intensive research and field evaluation these products were first introduced commercially to the farmer in 1946 and in the fourth year of use in Britain, 1949, it has been estimated that something of the order of 1,000,000 acres were treated with them.

Until the last few years, however, almost the sole use of all these chemicals was on cereals. The field is now rapidly expanding and we have selective weed-killers capable of killing out a wide range of deleterious weeds in such additional crops as linseed and flax, peas and lucerne, onions and carrots and so on. The present paper seeks to inquire into the status of the 'hormone' weed-killers as selective agents for the removal of weeds from pasture.

Let it be said quite frankly that whilst we now know a great deal about what weeds we can kill, with what products under what conditions, we know next to nothing about the economics of such

Fig. 1.—A strip of untreated grassland showing the effect of applying MCPA to buttercups on either side

Fig. 2.—On the left is untreated pasture with ragwort ; on the right the pasture has been treated with MCPA

applications. We know the costs of applications that will remove buttercups, thistles, rushes and other weeds from pasture, but the precise benefits to be realised in terms of increased milk yields on dairy farms or in live-weight increases in fattening stock are unknown. It is also unfortunate that the experimental work necessary to make these deductions is exceedingly difficult, in fact no really suitable technique has yet been worked out.

THE AGENTS

The chemicals so far used in Britain in experimental and practical work on grassland have been 2-methyl-4-chloro-phenoxyacetic acid (MCPA) and 2,4-dichloro-phenoxyacetic acid (DCPA or 2,4-D), both as the water-soluble sodium salts. The former is now usually available as a dust containing 1% of the active material or as a liquor containing 28% of the sodium salt equal to 25% acid equivalent; 2,4-D is normally sold as the crystalline solid containing 80% to 95% sodium salt or 73% to 87% acid equivalent.

Although theoretically it would be much better to refer to dosages per acre in terms of acid equivalent, as is done in America, so far in Britain reference has usually been made to pounds of sodium salt per acre. For pasture work it is normal to apply 2 to 4 lb. of sodium MCPA or sodium 2,4-D per acre, either as dust or as a solution in anything from 5 to 100 gallons per acre according as low- or high-volume application methods are employed.

Times of application vary with the season and with the stage of growth of particular weeds, but generally speaking most effective results on weeds and least damage to grass are experienced when both are growing vigorously. It follows, therefore, that the best and safest results are experienced in a warm or wet growing season and the worst in a cold or dry season. The spring and summer seasons of 1946 and 1948 were much better from this point of view than those of 1947 and 1949.

Buttercups

With these preliminary remarks we may consider a number of typical pasture weeds in some detail. Perhaps buttercups are some of the most prevalent weeds in British grassland, certainly they are most striking, but different buttercups react in quite different ways. Two pounds of MCPA per acre give excellent control of the creeping buttercup (*Ranunculus repens*) and this is an instance where MCPA is very much more efficient than 2,4-D. Bulbous buttercup (R. *bulbosus*) is much more resistant, and will not often pay for treatment, although the writer saw a complete clearance of this weed with an application of 5 lb. of MCPA per acre in the dry summer of 1949. Crowfoot buttercup (R. *acris*) is intermediate in susceptibility, or resistance, to the ‘ hormone ’ weed-killers. In all cases application should be made in the spring or early summer after the weeds have produced sufficient foliage to be sure they will absorb a toxic dose of the chemical, well before they flower (Fig. 1).

Thistles

Thistles again are common grassland weeds and probably the worst is the creeping variety (*Cirsium arvense*). This is controlled by 2 lb. of MCPA or 2,4-D, but in this instance application should be delayed until the plants are three parts grown and approaching the flowering stage. Good results are also often obtained in the autumn. Even if a complete clearance is not achieved in a single season it is unlikely that the surviving weeds will develop sufficiently to produce and spread seed. (We have certainly gone a long way in the forty years since the writer, when fetching up cows on his father's dairy farm, normally carried a tiny hoe for ' spudding ' thistles !)

Rushes

In much of our damp land, in the Romsey Marsh and Dorset water meadow areas, for example, rushes (*Juncus* spp.) can be a great scourge. Curiously enough this problem was not tackled in England in the early stages of the ' hormone ' weed-killer development, possibly because on superficial examination rushes looked rather like grasses. It remained for workers in Northern Ireland and Eire to demonstrate that rushes are relatively quite susceptible and may be killed out by applications of about 2 lb. of MCPA per acre. The efficiency of this treatment is increased if the rushes are cut over with the scythe or mowing machine before the chemical application (Fig. 2).

Docks

Docks (*Rumex* spp.) are a rather more difficult problem. Seedling docks of most species and well-developed curled-leaved docks are reasonably well controlled by MCPA or 2,4-D at 3 or 4 lb. per acre. Old-established, broad-leaved docks, however, are very resistant and even repeated, heavy applications are seldom entirely effective. It has been suggested that if a heavy roller is run over docks before treatment then absorption of the chemical is facilitated and greater efficiency is achieved. This is certainly an interesting proposition, but the evidence is as yet rather slender.

Ragwort

A deal of work has been carried out on the control by selective weed-killers of ragwort (*Senecio Jacobea*). A year ago the writer would have said, in fact did say, that this problem had been solved. Work in various parts of the country had shown that as little as 2 lb. per acre of MCPA could control ragwort both in the early, rosette stage and at the much later stage just before flowering. In the dry season of 1949, however, quite contradictory results were obtained in different parts of the country using low and high applications of MCPA at both the stages mentioned. It is obvious that more field investigation is called for on this particular weed.

Before leaving this aspect of the subject it is of interest to note that quite large quantities of MCPA liquor are used in Holland, entirely on pasture, and MCPA is much preferred to 2,4-D because of its greater

margin of safety. The weeds mainly concerned there are buttercups, thistles, and dandelions (*Taraxacum officinale*). MCPA is not used on cereals because it is not effective against the most prevalent weed, corn marigold (*Chrysanthemum segetum*).

Some difficulties

It must be emphasised that the use of chemical weed-killers on pasture must be accompanied by other measures of good grassland management if the maximum benefits are to be derived. Proper attention to drainage and liming, removal of surface ' mat ' by means of a tined harrow and application of fertilisers all have their part to play.

It is frequently said that the only worthwhile treatment for really bad, weedy pasture is to plough out and reseed. But quite apart from the fact that this is not always practicable, even where it is practised it does not always overcome the weed problem by any means. Freshly reseeded pastures frequently produce huge quantities of weeds that cannot always be overcome by a judicious use of the mower, and chemical weed control can be a valuable adjunct.

We must now deal with one or two of the possible snags of the treatments outlined above. It is well known that legumes are susceptible to ' hormone ' weed-killers. What is the position regarding clover? It is now well authenticated that established clover is set back by such applications, but in plot experiments on swards containing plenty of clover it is seldom possible to distinguish the plots by differences in clover populations or vigour in the following season. On the other hand seedling clovers can fairly easily be killed out completely by MCPA or 2,4-D, a fact which must be borne in mind if treatment of freshly reseeded pasture is contemplated.

There has also been considerable discussion on the possibility that weed treatment in pastures may remove some plants which either act as appetisers or provide cattle with minor elements necessary to proper nutrition. This is rather a vague possibility and to the best of the writer's knowledge there is no direct evidence one way or the other. We can only class it as a factor which is, as our Scottish friends would say, ' non proven.' It seems unlikely that weed-killing in pasture will become so widespread as to affect this issue. Incidentally, it has repeatedly been noticed that when cattle are allowed to graze on plots treated and untreated with these non-poisonous products, they invariably chose the treated plots first.

Considerable attention has for a long time past been given to the possible ill effects of agricultural chemicals on bees. The ' hormone ' weed-killers are not very dangerous to bees when used by the old conventional, high-volume spraying methods, *i.e.* spraying at the rate of say 70 to 100 gallons per acre. But low-volume methods using 5 to 10 gallons per acre involve the use of correspondingly more concentrated solutions which can be poisonous. It is best, therefore, to avoid spraying when weeds, and particularly dandelions, are in flower.

Having touched on the question of application it is worth pointing out that, so far as present evidence goes, there is not a great deal of difference in efficiency between the use of high- and low-volume methods. It is true that Professor Blackman, in his recent ' Fernhurst ' lecture to the Royal Society of Arts, gave preliminary figures to show that, under some conditions at least, intermediate-volume applications of the order of 25 or 35 gallons per acre need rather less active chemical than either high- or low-volume applications for the same weed-killing effect. It seems likely, however, that the reduced costs of application per acre made possible by the newer low-volume methods may override slight savings in product when greater quantities of water are used.

Costs of spraying

Spraying costs are even more dependent upon the rate of spraying per day and, of course, per season, as the following figures show. They are worked out for a farmer doing his own spraying against creeping buttercup, using a low-volume sprayer, and achieving acreages of 50 down to 10 per day for a period of only 10 days during a season, *i.e.* for 500 down to 100 acres per season.

Costs	*Acres per day*		
	50	25	10
	s. d.	*s. d.*	*s. d.*
(1) ⅝ gall. triple strength MCPA liquor at 31*s.* per gall.	20 8	20 8	20 8
(2) Tractor at £1 a day, man at £1 a day plus 25% for supervision, etc. ...	1 0	2 0	5 0
(3) Assume sprayer and repairs £100, used 10 days at 50 (25 or 10) acres and write off in 2 years	2 0	4 0	10 0
Costs per acre	23 8	26 8	35 8

For the control of more resistant weeds, as much as a further 20*s.* 8*d.* must be added to the above figures.

The contractor covering a much larger area in the season will obviously be able to cut these costs, but will have to add other charges to cover his organisation and profit.

To sum up, we now know how to control a fairly wide range of the more noxious weeds in pastures with the new weed-killers ; we know approximately how much such applications will cost, provided the conditions of work are defined ; but we cannot yet measure the precise cash benefits. There are, of course, still a few farmers who take pride in the appearance of their farms and will want weeds removed irrespective of cost. But, broadly speaking, it can be said that poor pasture which is practically worthless because of serious weed infestation, and which for one reason or another cannot be ploughed and reseeded, is worth treating with the new chemical tools.

THE SAFE HANDLING OF PHOSPHORUS INSECTICIDES WITH SPECIAL REFERENCE TO PARATHION

by W. R. ORRELL, B.SC., F.R.I.C.
(*Chief Chemist, Yalding Laboratories*)

THE safe handling of dangerous and poisonous substances is no new problem. It is one with which we are all familiar. Petrol is transported over every road in the world and over the seven seas. It is dispensed safely in every village. And why can it be dispensed safely ? Because everyone is familiar with its dangers and takes the appropriate precautions when handling it. If anything goes wrong or someone is foolish, the consequences are spectacular and widely publicised and the dangers of handling petrol are emphasised once again. But no one suggests that because, as a result of someone's carelessness, a petrol fire breaks out, the use of petrol should be banned !

In Britain a beneficient government provides (at a price) coal gas, laid on in pipes, to nearly every urban kitchen in the land. Coal gas is not only inflammable, it is very poisonous. At intervals we read in our papers that one of our citizens, depressed possibly at the increasing price of coal gas, has sought an end to his worries by " putting his head in the gas oven." But no one suggests that as a consequence the sale of gas should be prohibited.

Both petrol and coal gas, used properly and with common sense, though inherently dangerous, are in fact safely handled by the whole population because everyone knows they are dangerous and instinctively does the right thing when using them.

And so with insecticides. For years nicotine and the arsenates have been handled by farmers who have been educated in their use. They are both intensely toxic but the number of accidents when using them is infinitesimally low when compared with the tonnage used.

In the past few years the crop protection industry has been able to place at the disposal of the farmer a new range of insecticides and acaricides based on organic phosphorus compounds which are of extreme potency at very low dosages, and of exceptional safety as far as the crop is concerned. They are all, however, very poisonous to human beings and must be handled with care to avoid accidents.

One of these insecticides is parathion, and it is with the safe handling of this compound that I propose to deal in this short article. With minor variations, what I say about parathion applies also to the other well known members of this group, *e.g.* H.E.T.P., T.E.P.P. and the so-called systemic insecticides.

Parathion is an oily liquid with quite a low vapour pressure. It is toxic if it enters the body by the mouth or by the skin or any external surface of the body, including the hair or eyes. Its vapour is also toxic if it enters the lungs, but in the liquid form in bulk the low vapour pressure greatly reduces this hazard. This does not apply to certain formulations, as we shall see.

Now the first safety precaution to be taken by the user is really taken for him by the manufacturers, and it lies in the decision as to the type of formulation which should be offered to the farmer.

In America it was argued that as parathion was fairly readily absorbed through the skin, dispersible powders were to be preferred to liquids because there would be more danger in handling liquid concentrates than in handling concentrated dispersible powders. The latter, it was argued, could be easily shaken from the hands or body if by accident there was any spillage.

These considerations ignore one important point. Although it is true that the vapour pressure of parathion is low, it is equally true that the enormous internal surface of the lungs is one of the most absorbent and sensitive surfaces in the body. If therefore you breathe a dust on which is absorbed say 15% of parathion you will be presenting a heavy dose of the poison just where it can be most rapidly absorbed, and you will have put that dose on to a surface of the body where you cannot possibly wash it off. In England we argued that if we formulated the product as a liquid you would stand in little danger from absorbing it into the lungs at the mixing point of the spray routine. If you did spill some of the liquid on your hands or other surface of the body you did stand a good chance of washing it off the contaminated part before serious absorption into the system had taken place.

If for any reason you insist on using a dispersible powder, then the man doing the dilution and mixing *must* wear full protective clothing, including an efficient dust and gas mask.

The same principles should govern your precautions if you decide to dust with parathion. Frankly, until we have experience with parathion we strongly recommend you not to use dusts as it is difficult to see how you can avoid getting the toxic dust into the lungs. Further experience may show that it is difficult to absorb dangerous doses from the lower strength dusts, but for the present we suggest that you would do well to avoid their use.

If, after all your care in handling parathion, one of your workers is affected, you will find directions on the label of the product on how to apply first aid treatment, and you will find on the label also a note to the doctor on how to continue the treatment.

The symptoms of parathion poisoning are: (*a*) headache, nausea, diarrhoea and tightness of the chest; (*b*) slight twitching of the muscles of the eyelids and tongue, and (*c*) contracting pupils.

The first aid treatment involves the removal of the patient from further exposure and the immediate administration of two half milligram tablets of atropine sulphate by the mouth with a repeat dose of atropine sulphate after one hour if the symptoms are not relieved and the pupils are not back to normal. A doctor should of course be sent for immediately, and when calling him tell him what the trouble is and advise him to include atropine injections in his equipment. When he arrives draw his attention to the note to the doctor on the label.

You have seen that the general principles in handling parathion products are to keep the concentrates from contact with any part of the human body—mouth, lungs, skin, hair or eyes; to keep the diluted spray as far as possible from contact with the body and to become familiar with and equip yourself for first aid treatment if accidents occur.

These general principles lead to a set of rules which will vary somewhat according to circumstances, but the following may be useful as a guide to the sort of thing which many advisers may draw up for themselves.

General Instructions to the Farmer

1. Use a liquid preparation in preference to a dispersible powder or dust.

2. Read the directions and warnings on the label and follow them scrupulously.

3. Store the product under lock and key away from foodstuffs.

4. No one handling parathion or applying it must be allowed to smoke whilst on duty.

5. Neither food nor drink should be taken by anyone either during handling parathion or until they have had a general clean up and change of clothing.

6. Move animals and poultry away during spraying and do not let them return for at least four weeks in the case of parathion or 24 hours in the case of H.E.T.P. or T.E.P.P.

7. Do not apply parathion within four weeks of harvesting crops which will be eaten by human beings, animals or poultry.

8. It is advisable in cases where workers are exposed to spray drift for long periods to take them off the work at frequent intervals.

Instructions to the Man Mixing the Product

1. Change into an old suit kept on the farm and wear rubber boots,* rubber gloves with gauntlets, a rubber apron with bib, and goggles to protect the eyes. If a dispersible powder is being used, wear an

*Wherever rubber is mentioned in these notes, read ‘ natural rubber.’ Some synthetic rubbers are unsuitable.

approved gas mask. A Siebe Gorman mask with a C.C. canister has been successfully used.

2. Be very careful, when opening the containers, to do so without splashing.

3. Have handy at least one 3-gallon bucket containing soap and water or a suitable spreader and water (*e.g.* a teaspoonful of Agral LN to a bucket of water). This should be refilled with clean soap or spreader solution after every contamination.

4. If the concentrate is spilt on to any part of the body, wash it off immediately with this water.

5. If the concentrate is splashed into the eyes, flush them immediately with clean water and continue to wash them for 15 minutes. Meanwhile call a doctor. It is a good idea to have an eyebath as part of the first aid equipment.

6. If the concentrate is spilled on to the clothing, remove the contaminated clothes immediately, wash the skin underneath with clean soap or wetting agent and water, and then wash the affected clothing thoroughly.

7. When spraying is over for the day—

(*a*) Wash your machine out with water containing a pound of washing soda per 10 gallons.

(*b*) Wash out the empty containers twice with the water containing soda. Puncture holes in them or flatten them and then bury them.

(*c*) Lock up unused product in its store, ensuring first that any containers that have been opened have their caps securely replaced.

(*d*) Look round to see that no contaminated equipment is left unwashed.

(*e*) Keeping your gloves on, wash them in clean water and soap or spreader. Take off your rubber protective clothing and goggles, wash them and hang them up to dry. Wash your gloves again and take them off. It is a good idea to dry them and dust them inside with talcum powder so that they are ready to put on the next day. Keep your protective clothing in a suitable shed.

(*f*) Change from your old spraying clothes into your ordinary clothes. Wash your hands, arms and face thoroughly. Go home.

Instructions to Spray Gangs

1. Keep a suit of old clothes, dungarees or overalls on the farm specially for spraying.

2. Always wear rubber gloves, rubber boots and rubber aprons when spraying, and when spraying tall crops such as apples and hops wear also oilskins and sou'westers.

3. Occasional contact with drift from spray applied at 100 gallons per acre rates is not dangerous, but continuous contact is. If you are in constant contact with spray drift or if you are using ' low volume ' sprayers, wear complete protective clothing and a visor type helmet.

4. Do not spray in very windy weather.

5. Never clear blocked jets by blowing them out with the mouth.

6. If you are using horses for pulling the sprayer see that they are not continuously exposed to spray drift.

7. See that the spray is kept out of ponds and streams.

8. When you have finished spraying, wash your protective clothing, oilskins, etc., with soap or wetting agent and water and hang them up to dry. Pay particular attention to your rubber gloves and after washing and drying them, treat the insides with talcum powder so that they are ready for putting on the next day.

9. Have a good wash and pay particular attention to your hands, especially if you roll your own cigarettes.

10. Change into your ordinary clothes and go home.

11. If your overalls or spraying clothes are heavily contaminated with diluted wash, they should be washed before wearing again, otherwise wash them at least once a week.

* * *

Such numerous precautions may seem extremely difficult to apply, but in fact they are not, if the general principles are kept in mind. Once a simple ' drill ' has been established it will be found that parathion and the other phosphorus insecticides can be handled with safety.

Note.—Parathion products manufactured and sold by P.P. include :

1. ' Fosferno ' 20 (Dispersible Liquid) ;
2. ' Fosferno ' 15 WP (Wettable Powder).

PHOSPHORUS INSECTICIDES AND THEIR USES

By J. H. STAPLEY, B.SC., A.R.C.S.
(*Senior Entomologist at Fernhurst Research Station*)

BY phosphorus insecticides we now understand mainly:

Hexaethyltetraphosphate H.E.T.P. (20 per cent T.E.P.P.);

Tetraethylpyrophosphate T.E.P.P., which is the active ingredient of so-called H.E.T.P.;

Paranitrophenyldiethylthiophosphate or, as it is now called, parathion.

Probably also certain systemic insecticides which contain phosphorus, as does the only one so far used commercially, *viz*—

Bis (Bisdimethylaminophosphorous) anhydride.

H.E.T.P. has been widely used and is probably more widely used at present than parathion. In the U.S.A. both parathion and H.E.T.P. have been widely used; T.E.P.P. has been tried to a lesser extent under commercial conditions. Our experience has been principally with parathion.

Parathion has certain definite uses by virtue of its combined insecticidal and acaricidal properties. The obvious use in Great Britain is where aphid and red spider occur as pests together, *viz*, on fruit, on hops and in glasshouses. Other uses appear to be incidental to these main uses unless there are other outstanding advantages, *e.g.* in the control of mangold fly and white fly. Overseas, its most obvious use is for the control of pests on citrus, *viz*, scale insects, mealy bugs, white flies, leaf and rust mites, thrips and red spider. It would appear to be a mistake to try to develop parathion as an insecticide for purposes for which existing, less hazardous chemicals will serve, *e.g.* DDT, for control of codling moth.

We in Plant Protection Ltd. have used almost exclusively a dispersible liquid formulation, *i.e.* a liquid concentrate. This has certain definite advantages over wettable powder and emulsion types of product and would appear to have been a good choice, judging by American experience.

We may now consider results with parathion, firstly, in the spray programme on top fruit, *apples and plums*, as an alternative to winter washing. On apples the programme was as follows:

1. Green cluster—for control of aphids, woolly aphid, winter moth caterpillar, capsid and sucker.
2. Petal fall—for sawfly.
3. June, first week—for red spider.

At 0.01 per cent parathion (8 fl. oz./100 gallons of a 20 per cent dispersible liquid) we obtained perfect control of aphids and a variable control of winter moths. There were indications that woolly aphid was reduced. Unfortunately, we have no data ourselves on capsid and apple sucker, but capsid appear to be controllable.

A Petal Fall application at 0.01 per cent gave perfect control of sawfly, and it would appear that more latitude in timing may be permitted.

June (first week) gave a good check to red spider. Parathion is not ovicidal at normal concentrations and so careful timing in relation to winter egg hatch is necessary, but difficult to achieve.

On plums parathion was used 10 days after cot-split and gave excellent control of red spider and sawfly.

Our final recommendations are to use parathion at 0.005 per cent for aphids and sawfly and 0.0075 per cent for red spider.

The question of substitution of parathion for winter washing is still an open question, but good results have so far been obtained. We suggest that parathion should be used post-blossom, but we prefer BHC pre-blossom.

Parathion is ovicidal to aphid eggs if applied near to hatching.

On apples parathion will mix with lime-sulphur unless this is strong, *e.g.* 5 per cent. This is a material advantage over H.E.T.P. and T.E.P.P., which will not stand lime-sulphur, and apple spraying—at least at present—is based on lime-sulphur.

Phytotoxic hazards are uncertain, but we caused severe defoliation on Cox by a spray on June 21st at 0.01 per cent. At present we recommend that parathion should not be used after mid-June.

On hops parathion has proved outstanding at 4 fl. oz. ' Fosferno ' 20 per 100 gallons, *i.e.* 0.005 per cent parathion for control of aphids in 1949, a bad aphid year. At a low gallonage of 100 gallons per acre results have still been good.

Against red spider good results were obtained, but parathion is non-ovicidal at normal concentrations. The key to success is to spray early, *i.e.* late May or early June and to give two applications at an interval of 10 to 14 days. We have tried up to 0.02 per cent and found it no better than 0.005 per cent. At higher concentrations parathion is liable to cause yellowing and leaf fall, especially on the variety Fuggles, but less so on other varieties, *e.g.* Brewers Gold. Another season's experience is really required, but at present we are stopping parathion spraying on hops at the ' pin ' stage.

On glasshouse crops we have been interested in the development of parathion as a smoke. Azobenzene has been used in smoke since 1948 in this country, against red spider in glasshouses. Resistance to azobenzene developed in 1949, and growers returned to oil. Logically the answer was to develop another acaracide, and we started off in high hopes, but parathion proved valueless when used alone. Excellent

kills of the active stage were obtained at 0.5 gm. per 1,000 cu. ft., but the chemical was non-ovicidal. We now employ two generators side by side, one of azobenzene and one of parathion. A double smoking is given at an interval of 48 hours to make sure of killing all the eggs and spiders, as resting spiders and eggs on the point of hatching (*e.g.* five days old) can resist the smoke. Azobenzene can be reduced to 2 gm. as the ovicidal efficiency is very high, while the parathion kills the active stage.

Other glasshouse insects are also susceptible to parathion, principally white fly ; 100 per cent kill of adults, and 90 per cent of scales (nymphs) can be obtained with parathion. Leaf miner, aphids, leaf-hopper, thrips and certain caterpillars are also readily controlled. We have no data yet on mealy bug and scale.

We have also used parathion successfully as an atomised spray (spray aerosol) with similar results. This technique requires the use of a mask and is more difficult for the grower.

Parathion has been successfully used for the control of mangold fly on sugar beet, using at least 12 fl. oz. of ' Fosferno ' 20 per acre. It is relatively quick acting. We have made this a definite recommendation for the control of this insect. Other insects, no doubt, are controllable, but recommendations, at present, have not been worked out. It is important that the best use is made of this potent chemical, consistent with its toxicity to man, and that enthusiasm does not override discretion.

THE TREATMENT OF SEED WITH CHEMICAL SEED DRESSINGS

By J. F. H. Cronshey, M.A.
(*Senior Mycologist at Fernhurst Research Station*)

I. CEREAL SEED DRESSINGS

THE link between what we now know as seed-borne diseases and the minute contaminants of grain, both internal and external, could only be fully understood when the tool for examining them in detail—the microscope—had been invented. Many years before that, however, it had been demonstrated by experiments that there was a connection and, as is so often the case with 'scientific knowledge,' the value of seed treatment was known empirically a very long while indeed before the reason for this value was understood.

Seed treatment is probably the oldest of plant protection measures, and seed has been 'dressed' in this sense, as well as in the sense of separating it from chaff and weed seed, from the times of the ancient Greek and Roman civilisations. During much of this time the most serious 'seed-borne' disease of cereals in Europe was probably that carried with, rather than on, the seed—ergot of rye, with its appalling results to humans and animals. This importance, however, was not realised, and, if it had been, ergotism could have been avoided and ergot much reduced by purely mechanical 'dressing.' The next most troublesome disease, whose importance was most fully appreciated, was bunt or stinking smut of wheat. This very prevalent and serious disease produced obvious results both in transforming the affected grains, except their skins, into masses of black powder, and also in contaminating the whole mass of the grain with the unpleasant smell of the powder.

It is amusing to consider that this disease, the original seed-borne disease that stimulated the initial and so much of the subsequent development of seed treatments, is not naturally seed-borne at all. Without the intervention of man, the grain would fall to the ground and the disease spores would be released in the soil to germinate and attack other seed. Man, with his mixing of great masses of grain in threshing, has transformed a soil contamination into a direct seed contamination.

The early treatments for bunt, discovered by chance and empirical experiment, mostly consisted of steeps in materials available to the

farmer. They were usually concoctions of dung and urine or similar ' brews,' but an exception was the simple steeping in brine, discovered when grain salvaged from a shipwreck was found relatively free from disease. They were the empirical treatments, imperfectly understood and not at all widely known, up to the time when, in 1750-1752, Mathiew Tillet proved by direct field experiment that bunt was produced in the following crop when the black dust from bunt heads was used to contaminate healthy seed.

Having satisfied himself that the cause was contamination of the seed, Tillet had an explanation for the value of seed treatment and a reason to examine various treatments to find the best. But farmers were poor and, though he found several better steeps, he concluded that a very fair measure of control could be obtained from steeping in putrid urine, so that the great advance in knowledge of the disease led to no immediate improvement in the means of control. But from Tillet's discovery, followed by Prevost's later determination that the particles of the black powder grew into living organisms, and his observation of the effect of copper on them, came the modern developments in seed disinfection.

Seed dressings, therefore, were developed in the first place to control diseases whose causal organisms were carried on the seed. In fact, for a long time the development was almost entirely concentrated on the one major disease, bunt or stinking smut of wheat, caused by the fungus *Tilletia caries*. Only in the last twenty or thirty years has any serious attention been paid to other diseases.

This history has had a profound effect on the type of material that has been developed and it means that, though the method of treatment has been reduced to a fine art and the materials used progressively improved, yet there are still vast fields to be conquered and future developments are likely to exceed in magnitude all that has been done in the past. Indeed the developments of the last fifteen years have shown the promise of what is to come. In this period, seed dressing has been effectively extended from a few of the cereals to a large range of crops, and from a handful to a substantial range of diseases, and very recently to insect pests.

The value of copper sulphate against bunt was discovered a few years after the publication of Tillet's work, but it was not extensively used till a century later. Half a century later again, the value of formalin was discovered. Though the main aim was still to control bunt, this was a notable advance because formalin was also effective against covered smut of barley and the oat smuts. The same seed treatment could now be used to control four diseases. But discovery is not at once followed by general use, though this time it was only a quarter of a century before the new material took hold. By then, discovery had embraced two further advances, for the possibility of dry dressing had been demonstrated with copper carbonate and the exceptional activity of certain organic compounds of mercury had been recorded ; in fact, the first organo-mercurial seed dressings were coming onto the market.

The organo-mercurials proved really excellent seed dressings. They extended the range of use of the method, proved very efficient and economical, and were found to be applicable in the more convenient powder form.

These are the standard seed dressings for cereals today, and are also useful for some other crops. They are effective against the destructive leaf stripe diseases of oats and barley as well as against the covered smuts of wheat, barley and oats and loose smut of oats. In addition they greatly reduce the damage done to the seedlings by the foot rot diseases of the *Fusarium* group, and they control a number of seed-borne and soil-borne diseases of sugar beet, peas, flax, etc. They combine a certain amount of volatility with a degree of persistence that enables them both to protect the seed after sowing and to penetrate and kill fungus spores lodged in the crevices between grain and chaff; in fact, they will even kill spawn in the outer layers of the grain. It is only the deep-seated infections of the fully loose smuts that escape them.

They have, of course, one well-known disadvantage; they are poisonous to man and animals. This fault has been fully appreciated, and dressings such as 'Agrosan' GN have been specially selected because of their combination of high efficiency with relatively low poisonous properties. All due care must always be taken with dangerous materials, but the risks have been minimised as far as possible.

The penetration of the volatile materials takes time and, while bunt is well controlled by treatment immediately before sowing, it is advisable to treat oat seed some time before it is sown, to obtain the full effect of the dressing. Oat smuts—particularly the loose smut—are much less easily controlled than the covered smuts of wheat and barley, and formalin, with its great volatility, probably does give rather better results, against loose smut of oats in particular. A period of storage, however, makes 'Agrosan' treatment nearly as good and the mercurial has other obvious advantages. In the first place, it controls leaf spot and foot rot, and in the second, formalin-treated grain must be dried and sown immediately. It is a great convenience to be able to store treated grain and not to have to dry it after treatment.

These then were the seed treatments that had evolved by the 1930's, organo-mercurials, such as 'Agrosan' GN, that would control a range not merely of the smut diseases but also of the 'seedling blights' caused by the leaf stripe and foot rot diseases. As their use increased, machinery was developed for their application, until now seed dressing has become a recognised practice in many countries.

Very recently the range of use of the cereal dressings has been increased and promise given of a whole new range of dressings by the incorporation of insecticide as well as fungicide. 'Mergamma' itself, with its combination of fungus disease and wireworm control, is a most valuable addition to the farmer's weapons. But even more important is the suggestion that still other insects and diseases may be controlled by similar means. 'Mergamma' has accomplished the

impossible and made it look simple. I am sure that before the introduction of 'Gammexane' gamma BHC many entomologists would have stated categorically that the control of wireworm by chemical means could never be economic in field crops, owing to the difficulty of permeating the soil and the enormous bulk of soil to be treated. In fact, now the right material has been found, it is enough to apply it as a seed dressing. Indeed, in the words of the saying popular a few years ago, 'the difficult' has been accomplished and 'the impossible' may take only a little longer.

'Agrosan' GN and 'Mergamma,' like other mercurials, are not completely safe on seeds. Damage can be done if excessive concentrations are applied or if the seed is damp, but the margin of safety is considerable and seed that is in good condition will only be damaged by very excessive dressing rates. Both to avoid excessive dressing of some seed and to ensure a sufficient load on all for disease control, the dressings need to be well mixed with the seed. In practice, this proves very easy; a barrel or drum with a tight-fitting lid can be mounted on a home-made stand to rotate end over end, and this is a simple machine that can be constructed almost anywhere. If the container is half-filled with seed and the requisite dressing added, the seed can be 'churned' with the dressing for about three minutes by rotating the drum and the job is done. On a large scale, machines such as the Robinson 'Agrosan' Seed Dresser are designed for continuous treatment.

The materials designed primarily for control of seed-borne diseases have proved useful against some soil-borne fungi, but recent work, aimed primarily at soil-borne fungi, has produced a number of seed dressings of a different type that are generally superior against soil-borne diseases. These will be discussed in a further article.

TECHNICAL BREVITIES

As already explained in the first number of this Review, this section includes technical data, derived from many sources, relating to plant protection problems in their widest sense. Some of the information has been obtained from reports received from our overseas representatives, to whom we have pleasure in making acknowledgment. Wherever the information has been obtained from published literature we have given the reference to the publication concerned. We have to repeat our expression of indebtedness to the Heads of Jealott's Hill and Hawthorndale Laboratories (I.C.I.—Central Agricultural Control) for permission to make use of abstracts from literature prepared by their staffs.

INSECTICIDES

Termites on Sugar Cane Setts (*Termes* spp.)

Good results were obtained in India from the use of a 5% BHC dust (0.65% gamma BHC) applied in the cane furrow at planting at the rate of 20—25 lb. per acre. There was no damage to germination and the proportion of termite damaged setts was reduced from 80% on untreated to 5% on the treated area.

Termites on Wheat and Cotton

Successful control of these insects was obtained in India by combine drilling a 5% BHC dust (0.65% gamma BHC) at 28—112 lb. per acre with seed.

Crickets (*Gryllus* sp.), Cutworms (*Prodenia*, *Agrotis*, etc.), and Grasshoppers

Successful control of the blackheaded cricket (*Gryllus* sp.) was obtained in India by the use of 5% BHC powder (0.65% gamma BHC) made up as bait in winter and 5% BHC dusts used at 10—20 lb. acre in summer.

'Agrocide' 3, used as a bait poison, has been found very effective in Jamaica against cutworms, grasshoppers and crickets which attack tomato seedlings.

Moss and Lichen on Tea

Effective kill of moss and lichen growth was obtained in India with 100 gallons per acre of 1 in 20 'Ovicide' applied to leafless bases of unpruned tea. No damage to the tea plants was observed.

Red Spider (*Tetranychus bioculatus*) on Tea

'Sulfinette' ('Fernasul') used at 1—2% has been found to be effective on tea red spider in India.

Red-hairy Caterpillar (*Ansacta albistriga*)

Various strengths of BHC and DDT dusts at 30 lb. per acre and sprays at 30—40 gall. per acre were tried in Madras for the control of the red-hairy caterpillar, a serious dry crop pest of the army worm type. Mortality counts could not be accurate owing to larvae moving into the area, but a 0.05% spray of 50% crude BHC gave 60% kill, described as ' quite effective.' A 5% BHC dust gave 48% kill in the field crop, and over 60% when applied in barrier trenches. BHC dusts and sprays were quicker acting than those containing DDT, which gave slightly lower kills.

Hand picking is considered to be preferable to insecticide treatment under local farming conditions.

S. Ramachandran, *Madras Agric. J.*, 1950, 37 (1) : 22-7.

Wireworm Control in Sugar Cane Land

Heavy losses of plant cane in Louisiana caused by wireworms of the genera *Melanotus*, *Canoderus* and *Aeolus* make it unprofitable to retain fields as stubble cane. Most of the injury can be prevented by applying 400 lb. per acre of dusts containing 0.2% gamma BHC or 1% chlordane or toxaphene in the furrow with the cane setts.

—*E. K. Bynum*, *et al.* *J. Econ. Ent.* 1949, 42 (3) : 556-7.

Strawberry Weevil Control

The strawberry weevil, *Anthonomus signatus*, was well controlled in New Jersey by two dustings at 40 lb. per acre of refined BHC (1% gamma isomer) ; 5% chlordane was good ; toxaphene and lead-arsenate-sulphur were ineffective.

Christ, *E. G. and Driggers*, *B. F.*, *J. Econ. Ent.* 1949 : 42 (3) : 559.

Pineapple Mealy Bug Control

The pineapple mealy bug, *Pseudococcus brevipes*, which causes pineapple wilt, was completely controlled in Florida, for at least four weeks in preliminary tests, by 1% parathion dust at 0.35 oz. per plant. Half this rate was less effective. Two applications were no better than one. Mealy bugs were found on the roots of treated plants. Ripe fruit that had been dusted seven weeks before maturity at 0.48 oz. per plant carried only 0.01 p.p.m. parathion, and none was found in the flesh.

Osburn, M. R., *J. Econ. Ent.* 1949, 42 (3) : 557.

Corn Earworm Control

In field trials against corn earworm, *Heliothis armigera*, in New York State, DDT in mineral oil, applied to the silk channels (between tip of cob and external silks) at 0.6 c.c. per ear after completion of pollination, was better alone than with dichlorethyl ether or styrene dibromide.

The best dust treatment was 5% DDT applied three times per ear (four, six and eight days after mean silking date). Dusts giving over 75% of non-infested ears at harvest included 1% parathion, which left no residue on the husked ears.

Butler, *G. D. and Carruth*, *L. A.*, *J. Econ. Ent.* 1949, 42 (3) : 457-61.

Coffee Leaf Miner (*Perilenoptera coffella*)

In Brazil it has been found that 1% gamma-BHC will control the adults of coffee leaf miner, while 0.01% parathion spray will kill larvae inside the 'mines.' Alternate treatments of BHC and parathion at two-weekly intervals are recommended.

Rice Swarming Caterpillar (*Spodoptera mauritia*)

In India large scale effective control of this insect has been obtained with 5% BHC dust applied at 10—15 lb. per acre with rotary dusters. DDT was also found effective.

Rice Hispa (*Hispa armigera*)

It has been observed in India that rates as low as 5 lb. of 5% BHC (0.65% gamma-BHC) per acre are sufficient to give an effective control of rice hispa.

I.C.I. (India) Ltd. are now recommending dosages of from 5 lb. to 15 lb. of 5% BHC per acre.

Thecla basilides on Pineapple

In Brazil a 1% gamma-BHC dust is recommended for treating the flowers twice in the season at a 25-day interval. No taint has yet been detected on the fruit. DDT is also effective.

FUNGICIDES

Blister Blight (*Exobasidium vexans*) **of Tea**

Experiments carried out in Ceylon have shown that 'Perenox' used at 4 oz. per 10 gallons of water is an effective spray treatment used through low-volume sprayers at 14 gall. per acre. This is safe from the copper residue aspect and gave an 18% increase over control yields.

Sugar Cane Sett Treatment

The efficacy of seven organo-mercury compounds as sugar cane sett disinfectants was compared. All increased germination and shoot length and all except two reduced the incidence of pineapple disease. Best treatments were 1% 'Abavit' S, 1% 'Aretan', 1% 'Agrosan' GN and 'Hortosan' DP at 2 oz. per 10 gallons. Differences were not significant.

Rochecouste, E. ; *Rep. Sug. Cane Res. Sta., Mauritius*, 1948-1949 : 35-7.

BLISTER BLIGHT IN CEYLON

Dr. Roland V. Norris, Director of the Tea Research Institute of Ceylon, in an address at a meeting of the Standing Committee for Agency Affairs, gave a summary of what has been established so far as a result of the study of Blister Blight (*Exobasidium vexans*) of tea in Ceylon and steps taken in its control.

1. The disease is transmitted by spores. These spores are destroyed by a few minutes' exposure to direct sunlight but can live for a week in an atmosphere at 90 per cent humidity.

2. The spores alight mainly on the upper surface of leaves. Infection of under-surfaces is relatively small, which simplifies spraying problems.

3. Under special conditions of humidity and free moisture, *e.g.* dew, the spores germinate in six to 24 hours. On germination a mucilage is exuded which anchors the spore to the leaf and enables it to force a germ tube through the cuticle into the leaf tissue.

4. The germ tube is only able to penetrate leaves or stems up to 30 days old. Very occasionally it gains entry to an older leaf.

5. After the entry of the germ tube the fungus grows rapidly and causes translucent, *i.e.* semi-transparent, spots to appear in the leaf in 6 to 10 days. The fungus flowers and seeds, *i.e.* sporulates, in 18 to 21 days. The blister may, therefore, appear on leaves which are 30 plus 18 days old and give the false impression that old leaves are being attacked. The spores are ejected with considerable force and are wind-borne. Systemic fungicides may be found which are effective at this stage. The selection of resistant strains of tea must also be mentioned as a major method of control.

6. There is no resting stage of the spore which enables it to survive for long periods under adverse conditions. There is no alternative host (at present) which will harbour the disease. Drought and sunshine, therefore, give a large measure of control, and after a long drought it takes a considerable time for the level infection to build up.

The disease carries over through drought periods on new growth inside bushes, where a 'micro-climate' affords conditions favourable to the survival of the disease.

The fungus is highly susceptible to copper-based fungicides, and it is hoped the work now in progress will reveal other products free from some of the disadvantages inherent in the use of heavy metals.

—*The Tea and Rubber Mail.*

The Planters' Chronicle, *Vol. XLV*, *No.* 101 : p. 264 : *May*, 1950.

WEEDKILLERS AND HORMONE PRODUCTS

Water Hyacinth

This weed is controlled in India by two applications, each of 2 lb. active 'Methoxone' (5 pints 'Agroxone' 3), or 2 lb. 2,4-D per acre in 160 gallons of water, at an interval of ten days.

Use of Maleic Hydrazide as a Plant Growth Inhibitor

Experiments conducted in the U.S.A. have shown that maleic hydrazide has a selective herbicidal and growth inhibitory effect on plants, which is more pronounced on young plants. An effect on older plants may be failure to develop seeds or rhizomes. The chemical appears to have a temporary or permanent effect on growing tissues, depending on the dosage used, and might be found useful as a selective grass herbicide, a temporary inhibitor of plant growth and for preventing undesirable seed production and sprouting of stored tubers.

Agricultural Chemicals, *Vol. V No.* 5, *pp.* 35, 36 *and* 84, *May*, 1950.

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